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CONSTRUCTION OF A DEMONSTRATION AUTOMATIC FOCUSING REAR-SCREEN PROJECTOR

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This proposal for research is submitted in response to a request to construct an automatic-focusing, rear-screen projector for demonstration and evaluation.

I OBJECTIVE

The objective of the proposed work is to develop a working model of an automatic focusing rear-screen projector. The basic techniques to be used have been developed in the course of a preceding project and are reported in detail in the final report, "Automatic Focusing Techniques."

To evaluate feasibility, the proposed working model will incorporate all of the essential features of a rear-screen projection system but will not be designed and constructed as a prototype unit.

II SPECIFICATIONS FOR THE DEMONSTRATION UNIT

The following specifications are suggested as suitable for the purposes of the demonstration unit. Minor variations in the details of the specifications, as deemed desirable by the project monitor and SRI project leader or as required by the availability of specific components, can be mutually agreed upon in the early phases of the work.

A. Film Drive

A motor-driven film drive will be designed to handle rolls of 9-inch-wide (aerial) film with manually adjusted film speeds from 0 to 2 inch/second. Provisions for higher film-drive speeds for slewing are not considered necessary.

B. Film-Projection Light Source

The light source for proper illumination of a 9 X 9 inch area of film is a major component. A suitable illumination source might be obtained from government-furnished equipment; alternatively, a suitable

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light source can be purchased and modified for the demonstration unit. It is suggested that the light source be in the range of 1 to 2 kW, which should provide a suitable image itensity for focus demonstration purposes; however, a light of this power probably will not give the image-brightness level desired for operational rear-screen-projection viewers.

C. Image Magnification

Two values of image magnification will be selected, for example, 3X and 15X. Exact values will depend on the focal length of readily available precision projection lenses. These two values of magnification span the range of values that typically would be used in the scanning mode of operation where automatic focusing has the greatest value. In addition, previous theoretical study has shown that the automatic-focusing technique is most readily applicable to this magnification range.

A third, higher value magnification (near 70X) will be included to determine whether or not the automatic focusing system can be made to provide a useful range of automatic focus control at high magnification values. This will permit a complete evaluation of the automatic focusing system over the range of practical magnifications.

The interchange of lenses required for the different magnifications will not be a simple operator adjustment on the proposed demonstration unit but will require the mechanical interchange of the selected lens and the possible relocation of certain components in the focus-detection optics.

D. Lens Servo System

A servo system will position the projection lens to give a sharply focused image of the film on the viewing screen. The servo will be controlled by signals from the focus-detection sensor. The amplitude and frequency response of the servo will be designed to move the lens such that a film deviation of $\pm$ 1/4 inch from the nominal film plane can be correctly focused on the screen. The frequency response of the servo will be initially designed to achieve a 10 c/s frequency response.

Measurements of the actual vibration frequencies and amplitudes of the film, when moving at various scanning speeds, will be required to determine what frequency response is actually required by the lens-focus servo system. Investigation of the dynamics of the film motion will be made to determine what techniques might be used to reduce both the frequency and amplitude of the film displacement, and how best to optimize the compromise between the amplitude and the frequency of the film displacement in relation to the lens servo characteristics.

E. Focus-Detection Subsystem

The focus-detection subsystem will project a special optical pattern onto the film and detect the focus of the reflected image of this pattern. The previous project developed the theory for this basic focus

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detection technique. The engineering application of this technique to a rear-screen projection viewer will be the primary effort of this project.

Recent focus-detection work on a related project has extended this technique to permit the use of a transverse (rather than longitudinal) mode of motion for the focus-detection image. This mode eliminates the need for the vibrating pellicle mirror in the focus-detection optical system. This could simplify the optics and will thus be considered for application along with the basic longitudinal vibration mode.

III METHOD OF APPROACH

The major research and development efforts are to be concentrated on the focus-detection optics, electronics, lens servo system, and those characteristics of the film-drive system that contribute to the film-plane variation, thus causing the basic variations in focusing.

In order to concentrate on these areas basic to the demonstration of a working automatic focus-detection system on a rear-screen projector, the remaining components of the system will be kept as simple as possible, and the overall demonstration system will not be packaged in a cabinet or designed to serve as a prototype unit. The following four items will be procured, if possible, as off-the-shelf items from related equipment, or from a suitable government-furnished rear-screen projector.

(1) The viewing screen--approximately 27 X 27 inches

(2) Lenses--three high-quality projection lenses with focal lengths of approximately 12 to 14 inches, 4 to 6 inches, and 1 inch

(3) A film transport system for 9-inch-wide rolls of film

(4) A suitable light source for illuminating all or nearly all of a 9 X 9-inch frame. The source should preferably include a condenser collimating system and should have a minimum of 1 to 2 kW of light power.

If a suitable rear-screen projector cannot be readily furnished, [redacted] 25X1 can procure or construct the above items. Preliminary investigation indicates that a suitable light source can be obtained by modifying a [redacted] G-184 25X1 8 X 10 professional enlarger. Similarly, suitable lenses and a projection screen are also available.

Design and construction of a simple film transport for demonstration purposes is proposed as the most suitable method to obtain this component if it is not supplied by the client.

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IV ESTIMATED TIME AND CHARGES

It is anticipated that the proposed work can be accomplished in six working months. It is requested that the contractual period be for eight months to allow for possible delays in procurement of the necessary specialized components required for this project.

The total estimated cost for this project is shown in the attached Cost Estimate A and assumes that a suitable government-furnished rear-screen projector is available from which the four basic components described in Sec. III can be utilized. The total estimated cost for the alternate procedure in which [redacted] would procure or construct these items is shown in the attached Cost Estimate B.

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This proposal will remain in effect until 15 March 1967. If consideration of this proposal should require a longer period, the Institute will be glad to consider a request for an extension of time.

V CONTRACT FORM

It is requested that any contract resulting from this proposal be written on a cost-plus-fixed-fee basis.

VI REPORTING SCHEDULE

It is proposed to submit monthly letter reports during the duration of the project.

A short final report will be prepared describing the basic design and summarizing the performance of the demonstration unit.

VII PERSONNEL

It is anticipated that the following personnel will contribute to this project:

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[redacted]	Senior Research Engineer
	Staff Scientist
	Senior Research Engineer
	Senior Research Engineer

The biographies of these people are included.

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